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(54) METHOD AND APPARATUS FOR TREATMENT OF FLUIDS

VERFAHREN UND VORRICHTUNG ZUR BEHANDLUNG VON FLÜSSIGKEITEN

PROCEDE ET APPAREIL POUR LE TRAITEMENT DE FLUIDES

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Descripti n

Technical field

[0001] The present invention relates to a method and an apparatus for treatment of fluids. Fluids will in this context be understood as gases and liquid media as well as suspensions and emulsions.

State of the art

[0002] In recent years, ever greater demands have been placed on the environment wherever man has been present. There are many reasons for this. One is that modern man's mobility between different geographical areas means that pathogens find fertile breeding ground for development of extremely virulent strains. These can give rise to serious diseases for which there are as yet no cures.

[0003] In hospitals, pathogens can be transmitted from one patient to other persons - both patients and nursing staff- and these pathogens are transmitted further by direct contact or indirectly via instruments, clothes, food or the like. Hospital textiles are contaminated to a greater or lesser extent with pathogens. One problem is that the washing methods are not completely satisfactory as regards removal of pathogens from hospital textiles. In addition, there is a need for better and simpler methods for sterilization, on the one hand of sensitive equipment such as, for example, endoscopy instruments and catheters which do not tolerate conventional sterilization methods, and, on the other hand, in operations where instruments need to be sterilized directly and quickly as they may have become contaminated during surgery (the surgeon may, for example, drop special instruments, implants and the like).

[0004] Other environments where pathogens and other types of pollution are spread and which often have problems with poor air are schools, day nurseries, food shops, kitchens, ship cabins, industrial premises and the like, especially in poorly ventilated premises. A further problem area is "sick houses" with, for example, radon, mould, hexamine and the like, as well as premises which are being painted, papered, floored, etc.

[0005] Water is another area where ever greater demands are being placed both on purity and on minimizing the environmental pollution when treating drinking water and waste water.

[0006] These media, and media contaminated in other ways, have created considerable unrest and the need for effective decontamination processes.

[0007] A number of proposals for dealing with the abov mentioned probl ms have been put forward during th y ars, such as better ventilation, various types of filters and chemicals for purification of air and water. Since chlorin its lf is a burden on th environment, methods have been developed in several countries for purifying water with ozone (O_3) in drinking water installations and bathing facilities, and also ozone dissolved in water for cleaning, disinfection and sterilization of articles. The reaction capacity of ozone (2.07 V electrochemical xidation potential) is ascribed to th fact that it is a powerful oxidant. The high chemical reactivity is coupled with the unstable electron configuration which seeks electrons from other molecules, which thus means that free radicals are formed. In this process, the ozone molecule is broken down. By means of its oxidizing effect, the ozone acts rapidly on certain inorganic and organic substances. Its oxidizing effect on certain hydrocarbons, saccharides, pesticides, etc., can mean that ozone is a good choice of chemical in certain processes. A combination of ozone, oxygen, hydroperoxide and UV radiation means that the reaction proceeds much more quickly and more efficiently by virtue of the generation of more free radicals.

[0008] The inactivation of microorganisms with the aid of ozone and radicals is considered as an oxidation reaction. The membrane of the microorganism is the first to be attacked. Within the membrane/cell wall, the ozone and the radicals destroy nuclear material insid the cell/virus/spore. The inactivation reaction in the case of most microorganisms occurs within minutes, depending on the ozone dose and the amount of free radicals which are formed.

[0009] In most cases, ozone is used in the form of ozone water for

- removing or reducing chemicals, dyes, heavy metals, odour, and destroying pathogens in water-purification works,
- removing algae, fungus, deposits, and for reducing the use of chemicals in water-cooling systems and heat exchangers,
- treating water in pools, aquariums and fish farms,
- sterilizing bottles and jars which are used in the beverage and food industry.

[0010] Despite its solubility in cold water, ozone is broken down (=consumed) quickly, as is the case in air, which gives a great many different radicals and more or less stable by-products such as aldehydes, bromate and carboxylic acids. The degree of breaking down depends on the pH, the substance which is exposed and the temperature. Certain substances are broken down easily by the ozone. However, the majority of substances and molecules are oxidized more efficiently by free radicals which are formed by ozone and the media treated by ozone. Certain free radicals have a higher electrochemical oxidation potential than ozone (2.8 V for hydroxyl radical and 2.42 for oxygen (singlet)). Examples of common oxidants which can be formed are hydroxyl radicals ($HO^{\cdot}$), peroxyl radicals ($RO_2^{\cdot}$), (singlet) oxygen ($^1O_2$), diradicals ($R^{\cdot}\text{-}O^{\cdot}$) and alkoxy radicals ($RO^{\cdot}$).

[0011] Oxidation of rganic molecules is best und rstood on th basis f the two similar paths for reactions of $HO^{\cdot}$, $RO^{\cdot}$, $RO_2^{\cdot}$ and $^1O_2$ radicals. Most organic chem-

icals which are mixed with air as gases are oxidized by HO· radicals. Aliphatic molecules give RO_2· radicals which can undergo various reactions, the most significant of which is the conv rsion t an alkoxyl radical (RO·) via NO. Reactions of RO· radicals are rapid and produce new carbon radicals by cleaving or by intramolecular transfer of H atoms. A reaction cycle of intramolecular transfer of H atoms, formation of a new RO_2· radical, conversion to the corresponding RO· radical and, finally, a further intramolecular reaction can lead to highly oxidized carbon chains.

[0012] Aromatic molecules oxidize quickly with HO· radicals, which forms carbon radicals and phenols. Singlet oxygen ($^1O_2$) is important for oxidizing a great many organic chemicals, including amino acids, mercaptans, sulphides and polycyclic aromatic hydrocarbons. These too are rapid oxidation processes.

[0013] Consequently, ozone reacts with contaminants via two essential pathways. It can react directly, as molecular ozone (O_3), by reactions which are selective. In general, activated compounds (phenol, resorcinol, salicylate), olefins and simple amines are expected to react with molecular ozone, as are certain microorganisms.

[0014] Alternatively, ozone can react with contaminants via an indirect route, in which the free radicals, which are produced by decomposition of ozone and by reactions, serve as oxidants. These indirect reactions of the radical type are rapid and non-selective.

[0015] Organic contaminants which react slowly with molecular ozone, such as aliphatic acids, aldehydes, ketones and aromatic hydrocarbons, react to a greater extent via the non-selective radical route. Thus, the conditions which break down ozone, such as UV radiation, favour indirect and non-selective reactions where the free radicals formed are strong oxidants. In the case of air, the radical route has a predominant role in most oxidation processes. Even in situations where the first oxidation reaction between the ozone and contaminants takes place via the direct route, radicals are generated so that the subsequent oxidation takes place effectively and rapidly by means of radical reaction processes.

[0016] Since the radicals are non-selective, they can oxidize all reduced substances and are not limited to specific classes of contaminants, as is the case with molecular ozone.

[0017] As has been mentioned, UV radiation favours a rapid decomposition of ozone with subsequent formation of radicals. In those cases where contaminants absorb UV radiation (for example, tetrachloroethylene), direct photolysis ofthe pollutant contributes to the degree of oxidation.

[0018] In many apparatuses, ozone is generated by corona discharges. When a 6 - 7 eV electron int racts with an oxygen molecule (O_2), dissociation takes place. The oxygen atoms (O+O) which are formed are immediat ly combined with oxygen molecules to form ozone (O_3).

[0019] It is also known that UV radiation with a wavelength of approximately 183 nm gives rise to ozone in air. However, it is difficult to mak such lamps adequately effective for production f ozon in the large quantities which may be needed in many cases.

[0020] A number of trials on purifying air with ozon have been carried out, such as described, for example, in the patent US-A-5,186,907. The patent describes an apparatus for treatment of organic waste gases which contain toxic components as organic solvents. The gases are sucked into an enclosure by a fan and are initially exposed in the said enclosure to a first oxidizing member, for example a UV lamp, which causes oxygen in the air to form ozone. The oxidizing effect of the ozone means that most of the organic solution forms peroxide. The peroxide is then irradiated by a second oxidizing member, in this case a UV lamp which emits radiation at a wavelength of 365 nm, so that the peroxide is broken down almost completely to carbon dioxide, water and inorganic gas components by oxidation. At the same time, those parts of the organic gas which were not oxidized by the first oxidizing member and the ozone will be oxidized and broken down by the second oxidizing member.

[0021] The apparatus in accordance with the above is targeted at organic solvents such as isopropyl alcohol, where the first oxidizing member converts the solution to peroxide, which is then oxidized by the radiation from a UV lamp at a wavelength of 365 nm. This apparatus has a narrow scope of application, specifically for treatment of certain defined organic solvents.

[0022] In the patent US-A 5,260,036, a method of photochemically oxidizing gaseous halogenic organic compounds is disclosed. According to the patent, the compounds are exposed to UV light to oxidize them into gaseous oxidation products and reacting the gaseous oxidation products with a surface inside an oxidation chamber, where the surface a material which is chemically reactive with the gaseous oxidation products in order to produce solid reaction products incorporated in side walls of the chamber. This chemically sorbant internal surface material has a life of 1-3 months.

[0023] It is evident from what has been described above that ozone can be used to good effect for purifying, disinfecting and sterilizing within certain areas and in the case of certain substances. The use of ozone for the purpose of obtaining free radicals therefrom should, however, considerably increase the efficiency, the scope of application and the substances which can be rendered safe. This procedure has not until now been used effectively.

Summary of the invention

[0024] The object of the invention is to tackle the abov mentioned s t of problems with purification and disinfection of contaminated media such as air, water and solid articles, and also disinfection and sterilization

of articles in a more efficient manner than has been possible with previous methods and apparatuses. This is achieved by means of a procedure and apparatus according to the characterizing clauses of Patent Claim 1 and Patent Claim 6.

Description of the figures in the drawings

[0025] The procedure using preferred embodiments of apparatuses according to the invention will be described in detail hereinbelow and with reference to the attached drawings, in which:

- Figure 1 shows a cross-section of an apparatus according to the present invention;
- Figure 2 shows a cross-section of a development of the apparatus according to the invention;
- Figure 3 shows a cross-section of a further development of the apparatus according to the invention;
- Figure 4 shows a variant of the apparatus and an example of the use for production of a sterilizing gaseous fluid for sterilization of solid articles in a closed space; and
- Figure 5 shows another variant ofthe apparatus according to the invention adapted for a liquid-state fluid.

Detailed description of the invention

[0026] The procedure according to the present invention is as follows. The medium which is to be treated is preferably introduced into some form of enclosure. In the enclosure, the medium is exposed to UV radiation with a spectral distribution within the range of 180 - 400 nm. The wavelength of 183.7 nm in particular converts the oxygen in the medium to ozone molecules (O_3). The ozone molecules formed are at the same time decomposed by radiation within the abovementioned wavelength range, especially at a wavelength of 254 nm. At the same time, the O_2 formed is broken down to form atomic oxygen. In order to increase the efficiency during generation of free radicals, in particular $HO^{\cdot}$ radicals, oxides are added as catalysts. In order to obtain a greater amount of ozone and consequently more free radicals, further ozone is generated before the medium is irradiated.

[0027] An apparatus which is based on the abovementioned method is shown in Figure 1. The apparatus is designed as an enclosure 1 with at least one inlet 2 and one outlet 3. An oxidizing member 4 is arranged in the enclosure 1, in the preferred embodiment a number of UV lamps with a spectral distribution within the range of 180 - 400 nm. The lamps 4 are preferably placed in such a way that the entire area 5 around the lamps 4 in the enclosure 1 is illuminated with approximately the same intensity. The inner walls of th enclosure 1, at least in the area 5 around the lamps, are arranged so that they provid for a good reflection of the light from the lamps 4. A member 7 for circulating the air, for example a fan, is arranged at the outlet 3 in order to lead the air which is to be treated through the apparatus 1.

[0028] A number of catalysts 8 are also arranged in the enclosure in the area 5. They can be attached, for example, in a suitable manner to the reflecting inner wall of the enclosure. In the preferred embodiment, the catalysts comprise metal and/or metal oxide, such as noble metals, aluminium oxide, titanium oxide, silicon oxide and mixtures thereof.

[0029] The functioning is as follows. When the apparatus is to be used, the current to the lamps 4 is switched on and the fan 7 begins to rotate. The fan 7 sucks air into the inlet 2, which air flows through the enclosure 1 and through the area 5 where the lamps expose the air to UV radiation. Due to that the walls in the area 5 ofthe lamps are reflective, the air is exposed to the UV radiation to a higher degree, and thus increasing the efficiency. The spectral distribution of the UV lamps means that ozone molecules (O_3) are generated by the oxygen in the air, and especially by radiation at a wavelength of 183.7 nm. At the same time, radiation is generated by the lamps within a wavelength range of 245 -400 nm, within which wavelength range the ozone molecules are broken down to oxygen and free radicals, and contaminants to free radicals. Of particular importance are the wavelength of 254 nm and also the wavelength of 364.9 nm, at which increased efficiency in the generation of free radicals is obtained. The catalysts, which are placed in the area 5, render the process more effective by increasing the amount of free radicals per unit of time. By virtue of their susceptibility to oxidation, the free radicals start a chain reaction with the contaminants in the air. The free radicals, and to a certain extent the ozone, effectively break the bonds between the atoms in the molecules which contaminate the air. Microorganisms such as, for example, pathogens are rapidly killed off, and from organic and inorganic matter new free radicals are formed which are more or less reactive. The final products are in the main water vapour, air and carbon dioxide. This embodiment of the apparatus is primarily conceived for purification of air, for example in office premises, schools, gymnasiums, smoking rooms, cabins, toilets.

[0030] Figure 2 shows a development of the apparatus according to Figure 1. In Figure 2, the same components have the same reference numbers as in Figure 1. In the apparatus according to Figure 2, a section 1l of the enclosure 1 has further been connected to the inlet end 2 thereof The new section 1l is arranged with an ozone generator 9 of a suitable type. In the preferred embodiment, the ozone generator 9 is a small dark-discharge unit. In the gap between the electrodes, silicon or similar powder is packed or is mixed with the dielectric mat rial (c ramic), by which m ans the pow r is increased and the generator can be made small in size. Other ozone generators can also be conceived, such as

electrode plates with a certain air gap where discharges are generated between the plates, and also UV lamps which emit at a certain wavelength. By increasing the amount of ozone, the power is considerably increased. The ozone which is formed by the ozone generator reacts on the one hand directly with the contaminants in the air and is decomposed, and on the other hand is decomposed by the UV lamps to form free radicals in large quantity. This embodiment is primarily conceived for purification of air in large areas and/or areas which are heavily contaminated, such as industrial premises, smoke-damaged premises, stables, etc.

[0031] Figure 3 shows a third embodiment of the apparatus according to the invention. In this embodiment, a section 1II is placed downstream of the outlet 3 to the apparatus according to Figure 1 and 2. The section 1II is arranged with a filter 10. The filter 10 consists of porous oxidic ceramics, aluminum oxide, calcium hydroxide, magnesium hydroxide and active charcoal and carbonate. The filter is provided with a number of passages 11, in the preferred embodiment slightly inclined with respect to the direction of flow F in order to increase the contact surface between the filter and the air. The apparatus with the filter is primarily conceived for use in premises with organic gas, where the final products may be unidentifiable, or where there are chlorinated solvents, alcohols, ketones, aromatic compounds, dioxins, hexamine (hexamethylene tetramine), formaldehyde, ammonia, pesticides and herbicides. The abovementioned filter effectively deactivates these final products, and only water vapour, carbon dioxide and air escape from the outlet.

[0032] Since both the ozone and in particular the free radicals are short-lived, continuous generation of ozone and free radicals is necessary. The speed of rotation of the fan and consequently the flow rate are adapted to the amount of ozone which is produced in order to obtain an optimal functioning of the apparatus and in order to ensure that no untreated ozone escapes into the environment. The apparatus can be arranged, for example, with a timer which switches the apparatus on at specific time intervals. The flow of air through the apparatus also has the object of cooling the electronic components and warming the filter 10 to increase its efficiency.

[0033] By virtue of the modular system with different sections, it is simple to adapt the apparatus to the conditions in which it is to operate. Thus, it is possible to obtain apparatuses with everything from one section 1 with UV lamps to a serial connection of several sections 1 arranged one after the other, ozone generator 9 and filter 10. The fan 7 is also arranged on a section 12, Figure 3, and it thus forms a modular unit too. The sections can then be mounted on a suitable holder ledge 13, Figure 3, which is arranged on a suitable support. The holder ledge contains the electrical connection, circuit breaker and ptional timer. The electrical connections between the sections and the holder ledg 13 are preferably of the plug-in type. Great flexibility and ease of servicing ar obtained in this way since only the faulty section needs to be exchanged or r paired and it is not necessary to dismantl the entire apparatus.

[0034] Figur 4 shows an example of th scope of application and also the advantages of the modular system, for example for sterilizing articles etc., such as operating instruments and catheters which it has not been possible to sterilize, with optimal results, using conventional methods. Figure 4 shows a cabinet 20 or other well-defined enclosure provided with a door, hatch r similar (not shown) which seals it tight when it is closed. The articles which are to be treated are placed in the cabinet 20, for example on perforated shelves 21. It is also conceivable to use holders specially adapted for the articles which are to be treated. What is important is that the air with free radicals can circulate freely around the articles. Air is drawn in through an inlet 22 provided with a closable valve 23. Connected to the inlet 22 is in the first place a section 1I with an ozone generator which converts oxygen in the incoming air to ozone molecules. Downstream of the section 1I with the ozone generator, as viewed in the direction of flow, there is a second section 1 with UV lamps and catalysts. The radiation from the UV lamps forms ozone and breaks down the latter and the previously formed ozone molecules to give free radicals which flow in large quantity out into the cabinet and sterilize the articles which are placed on the shelves 21. At the upper edge of the cabinet there is a fan secti n 12, and also a section 1II with filter arranged at an outlet 24, which outlet is provided with a closable valve 25. The fan section 12 generates a flow of air from the inlet 22, through the cabinet and out through the outlet 24. The cabinet is preferably provided with a member which locks the door when the apparatus is in operation, and which indicates this, for example by means of a lamp. The cabinet is also provided with a time control for th apparatus, adapted to the size of the space and to the size and shape of the articles which are to be treated. The cabinet 20 can be of different sizes depending on what is to be treated. It may be adapted, for example, for disinfecting and sterilizing of textiles in the form of operating gowns and the like, which are used in hospitals, the pharmaceutical industry, abattoirs, the electronics industry, etc.

[0035] The procedure described above and the apparatus can of course also be used to purify contaminated water, on the one hand, and on the other hand to use water enriched with free radicals for cleaning, disinfecting and sterilizing of instruments, electronic devices, biomaterial and textiles, for example. Figure 5 shows an example of the use of the present invention for treating water, i.e. decontaminate water or enrich water with free radicals. In this embodiment, one or more sections 1 with UV lamps are placed in the water flow 30. Arranged in a suitable manner upstream of the sections 1 is a connection 31, to which connection 31 a section 1I with oz ne generat r 9 and a fan secti n 12 ar joined. Between the connection 31 and the water inflow 30 there

is some form of nonreturn valve. When circulation of the water through the apparatus is required, i.e. when there is no external flow through the apparatus, a pump 32 is used. The water which flows through is first exposed to ozone from the ozone generator 9, where the ozone is forced down into the water by the fan 7. Ozone is thus added continuously to the water, which ozone water is then immediately irradiated with UV light in order to decompose the ozone and obtain free radicals. When the water is heavily contaminated, or when large amounts of free radicals in the water is needed, an ultrasonic device (33) is placed at the water inflow. High amplitude ultrasonic waves generate free radicals and break contaminants. And in the same way as with the apparatus described above, the apparatus for purifying water can be combined in a number of ways by virtue of the modular system.

[0036] The procedure according to the present invention permits a more effective purification, disinfection and sterilization in many areas of application and for many organic and inorganic substances, contaminants and microorganisms in air, in water and on solid objects. Examples of advantages are low energy consumption, no heating of objects, air or water, no chemicals/cleaning agents, small size of the unit, no toxic by-products, long service life, low maintenance and many applications:

Claims

1. Method for treatment of fluids, comprising the steps of generating ozone in the fluid, exposing the ozone to UV radiation at the same time as it is being generated with at least one UV generating member, arranged in the fluid, thereby breaking down the ozone and obtaining free radicals to destroy contaminants, **characterized in** exposing the fluid to at least one catalyst at the same time as the ozone is broken down for increasing the amount of free radicals.

2. Method according to Claim 1, **characterized in that** the said fluids include water or air.

3. Method according to Claim 1 or Claim 2, **characterized in that** the UV radiation which is emitted for breaking down the ozone and contaminants has a wavelength of 245 nm - 400 nm.

4. Method according to Claim 3, **characterized in that** the UV radiation which is emitted for breaking down the ozone has a wavelength of 254 nm.

5. Use of a fluid treated according to any one of Claims 1 - 4, for cleaning, disinfecting or sterilizing of solid obj cts.

6. Apparatus for treatm nt of fluids, which comprises an enclosure (1) provided with at least one inlet (2), at least one outlet (3), at least one UV gen rating member (4) arrang d in the enclosure (1) capable of generating ozone and at the same time breaking down the ozone to free radicals, **characterized in that** it is provided with at least one catalyst (8) for increasing the amount of free radicals, which at least one catalyst is arranged adjacent said UV generating member.

7. Apparatus according to Claim 6, **characterized in that** the said at least one catalyst comprises noble metals, titanium dioxide, aluminium oxide or silicon oxide, and mixtures thereof.

8. Apparatus according to either Claim 6 or Claim 7, **characterized in that** the said at least one catalyst (8) is placed in the area (5) near the UV generating member (4).

9. Apparatus according to Claim 6, **characterized in that** the fluid includes air or water.

10. Apparatus according to Claim 6, **characterized in that** the UV generating member (4) is at least one UV lamp which emits radiation with a spectral distribution within the range of 180 - 400 nm.

11. Apparatus according to Claim 10, **characterized in that** the UV lamp emits radiation at wavelengths of 183.7 nm and 254 nm.

12. Apparatus according to any one of the preceding Claims 6-10, **characterized in that** it is provided with a flow member (7) which moves the fluid which is to be treated through the enclosure (1).

13. Apparatus according to any one of the preceding Claims 6-12, **characterized in that** it is provided with a further ozone generator (9) placed upstream of the said UV radiating member (4).

14. Apparatus according to any one of the preceding Claims 6-13, **characterized in that** a filter (10) is placed downstream of the UV generating member (4).

15. Apparatus according to Claim 14, **characterized in that** the filter (10) consists of a oxidic porous ceramics with a number of passages (11).

16. Apparatus according to Claim 15, **characterized in that** the filter (10) also includes activ charcoal and carbonate.

17. Apparatus according t any one of the preceding Claims 6-16, **characterized in that** it comprises a

tim r for controlling its peration.

18. Apparatus according to any on of the preceding Claims 6-17, **characterized in that** the apparatus is made up of sections with different components in each section in order to obtain a modular system.

19. Apparatus according to Claim 6 for sterilizing solid objects, **characterized in that** it further comprises a closed space (20) with an inlet (22) and an outlet (24) and **in that** at least one ozone generator (9) is arranged in the inlet, **in that** the at least one UV generating member (4) is arranged downstream of this ozone generator (9), and **in that** a flow member (7) is arranged in the outlet (24).

20. Apparatus system according to Claim 19, **characterized in that** the outlet is arranged with an oxidic filter (10).

21. Apparatus according to Claim 20, **characterized in that** the filter (10) consists of a oxidic porous ceramics with a number of passages (11).

22. Apparatus according to Claim 21, **characterized in that** the filter (10) also includes active charcoal and carbonate.

23. Apparatus according to Claim 19 or Claim 20, **characterized in that** the inlet (22) and the outlet (24) are arranged with closable valves (23, 25).

24. Apparatus according to Claim 6 for treatment of liquids, **characterized in that** in a defined liquid flow (30) a member is arranged for generating and supplying ozone (9, 12, 31) to the liquid, and that the at least one UV generating member (4) is arranged downstream of the said member for simultaneously generating and breaking down ozone to free radicals.

25. Apparatus according to Claim 24, **characterized in that** an ultrasonic device (33) is arranged at the inlet of said liquid flow (30), so that said liquid flow is subject to ultrasonic action.

26. Apparatus according to Claim 24, **characterized in that** the said liquid flow (30) is connected to a washing apparatus for cleaning, disinfecting or sterilizing solid objects.

Patentansprüche

1. Verfahren zur Behandlung von Fluids, das die Schritte aufweist Erz ugen von Ozon in dem Fluid; Aussetzen des Ozons iner UV-Strahlung während es erzeugt wird, um dadurch das Ozon aufzubrechen und freie Radikale zu erhalten, um Schmutzstoffe zu zerstör n, **g kennzeichn t durch** Aussetz n des Fluids mindestens inem Katalysator zur gl ichen Zeit, zu der das Ozon aufgebroch n wird, zur Erhöhung der Menge freier Radikale.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Fluids Wasser oder Luft einschließen.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die UV-Strahlung, die zum Aufbrechen des Ozons und der Schmutzstoffe ausgestrahlt wird, eine Wellenlänge von 245 nm - 400 nm besitzt.

4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, dass** die UV-Strahlung, die zum Aufbrechen des Ozons ausgestrahlt wird, eine Wellenlänge von 254 nm besitzt.

5. Verwendung eines nach einem der Ansprüche 1 - 4 behandelten Fluids zum Reinigen, Desinfizieren oder Sterilisieren von festen Objekten.

6. Vorrichtung zur Behandlung von Fluids, die eine Umschließung (1) besitzt, die mit einem Einlass (2), mindestens einem Auslass (3), mindestens einem UV-erzeugenden Element (4), welches in der Umschließung (4) angeordnet ist, ausgestattet ist, in der Lage, Ozon zu erzeugen und gleichzeitig das Ozon in freie Radikale aufzubrechen, **dadurch gekennzeichnet, dass** sie mit mindestens einem Katalysator (8) zum Erhöhen der Menge freier Radikale ausgestattet ist, welcher mindestens eine Katalysator benachbart zu dem UV-erzeugenden Element angeordnet ist.

7. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** der mindestens eine Katalysator Edelmetalle, Titaniumdioxyd, Aluminiumoxyd oder Siliziumoxyd und Mischungen davon aufweist.

8. Vorrichtung nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** der mindestens eine Katalysator (8) in dem Bereich (5) nahe des UV-erzeugenden Elements (4) platziert ist.

9. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** das Fluid Luft oder Wasser einschließt.

10. Vorrichtung nach Anspruch 6, **dadurch gek nnz ichnet, dass** das UV-erzeugende Element (4) mindestens ein UV-Lampe ist, welche Strahlung mit einer Spektralvert ilung innerhalb des Bereichs v n 180 - 400 nm ausstrahlt.

11. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** di UV-Lampe Strahlung mit Wellenlängen von 183,7 nm und 254 nm ausstrahlt.

12. Vorrichtung nach einem der Ansprüche 6 - 10, **dadurch gekennzeichnet, dass** sie mit einem Flusselement (7) ausgestattet ist, welches das zu behandelnde Fluid durch die Umschließung (1) bewegt.

13. Vorrichtung nach einem der Ansprüche 6 - 12, **dadurch gekennzeichnet, dass** sie mit einem weiteren Ozonerzeuger (9) ausgestattet ist, der stromaufwärts von dem UVstrahlenden Element (4) platziert ist.

14. Vorrichtung nach einem der Ansprüche 6 - 13, **dadurch gekennzeichnet, dass** ein Filter (10) stromabwärts von dem UV-erzeugenden Element (4) platziert ist.

15. Vorrichtung nach Anspruch 14, **dadurch gekennzeichnet, dass** der Filter (10) aus oxydischer, poröser Keramik mit einer Anzahl von Passagen (11) besteht.

16. Vorrichtung nach Anspruch 15, **dadurch gekennzeichnet, dass** der Filter (10) auch Aktivkohle und Karbonat einschließt.

17. Vorrichtung nach einem der Ansprüche 6 - 16, **dadurch gekennzeichnet, dass** sie einen Timer zur Steuerung ihres Betriebes aufweist.

18. Vorrichtung nach einem der Ansprüche 16 - 17, **dadurch gekennzeichnet, dass** die Vorrichtung aus Sektionen mit unterschiedlichen Komponenten in jeder Sektion aufgebaut ist, um ein modulares System zu erhalten.

19. Vorrichtung nach Anspruch 6 zum Sterilisieren fester Objekte, **dadurch gekennzeichnet, dass** sie weiter aufweist einen geschlossenen Raum (20) mit einem Einlass (22) und einem Auslass (24), und dass mindestens ein Ozongenerator (9) in dem Einlass angeordnet ist, dass das mindestens eine UV-erzeugende Element (4) stromabwärts von dem Ozongenerator (9) angeordnet ist, und dass ein Flusselement (7) in dem Auslass (24) angeordnet ist.

20. Vorrichtung nach Anspruch 19, **dadurch gekennzeichnet, dass** d r Auslass mit einem oxydischen Filter (10) ausgestattet ist.

21. Vorrichtung nach Anspruch 20, **dadurch gek nnz ichnet, dass** der Filt r (10) aus oxydischer, poröser K ramik mit ein r Anzahl an Passagen (11) besteht.

22. Vorrichtung nach Anspruch 21, **dadurch gek nnzeichnet, dass** d r Filt r (10) auch Aktivkohle und Karbonat einschließt.

23. Vorrichtung nach Anspruch 19 oder 20, **dadurch gekennzeichnet, dass** der Einlass (22) und der Auslass (24) mit verschließbaren Ventilen (23, 25) ausgestattet sind.

24. Vorrichtung nach Anspruch 6 zur Behandlung von Flüssigkeiten, **dadurch gekennzeichnet, dass** in einem definierten Flüssigkeitsfluss (30) ein Element zum Erzeugen und Fördern von Ozon (9, 12, 31) zu der Flüssigkeit vorgesehen ist, und dass das mindestens eine UV-erzeugende Element (4) stromabwärts von dem Element zum gleichzeitigen Erzeugen und Aufbrechen des Ozons in freie Radikale angeordnet ist.

25. Vorrichtung nach Anspruch 24, **dadurch gekennzeichnet, dass** eine Ultraschalleinrichtung (33) an dem Einlass des Flüssigkeitsflusses (30) vorgesehen ist, so dass der Flüssigkeitsfluss Ultraschallwirkung ausgesetzt ist.

26. Vorrichtung nach Anspruch 24, **dadurch gekennzeichnet, dass** der Flüssigkeitsfluss (30) mit einer Waschvorrichtung zum Reinigen, Desinfizieren oder Sterilisieren fester Objekte verbunden ist.

Revendications

1. Procédé de traitement de fluides, comprenant les étapes consistant à produire de l'ozone dans le fluide, à exposer l'ozone à un rayonnement UV au même moment où il est produit, avec au moins un élément générateur d'UV, disposé dans le fluide, moyennant quoi on décompose l'ozone et on obtient des radicaux libres pour détruire des contaminants, **caractérisé en ce qu'on** expose le fluide à au moins un catalyseur au même moment où l'ozone est décomposé pour augmenter la quantité de radicaux libres.

2. Procédé selon la revendication 1, **caractérisé en ce que** lesdits fluides comprennent de l'eau ou de l'air.

3. Procédé selon la revendication 1 ou la revendication 2, **caractérisé en que le** rayonnement UV qui est émis pour décomp ser l'ozone et les contaminants a une longueur d'onde d 245 nm - 400 nm.

4. Procédé selon la revendication 3, **caractérisé en ce que** le rayonnement UV qui est émis pour dé-

compos r l'ozone a une longueur d'onde de 254 nm.

5. Utilisation d'un fluide trait´ selon l'une quelconque des revendications 1 à 4 pour le nettoyage, la désinfection ou la stérilisation d'objets solides.

6. Appareil pour le traitement de fluides, comprenant une enceinte (1) équipée d'au moins une entrée (2), au moins une sortie (3), au moins un élément (4) générateur d'UV, disposé dans l'enceinte (1) et capable de produire de l'ozone et, dans le même temps, de décomposer l'ozone en radicaux libres, **caractérisé en ce qu'il** est équipé d'au moins un catalyseur (8) pour augmenter la quantité de radicaux libres, ce catalyseur, au nombre d'au moins un, étant disposé de façon contiguë audit élément générateur d'UV.

7. Appareil selon la revendication 6, **caractérisé en ce que** ledit catalyseur, au nombre d'au moins un, comprend des métaux nobles, du dioxyde de titane, de l'oxyde d'aluminium ou de l'oxyde de silicium et des mélanges de ceux-ci.

8. Appareil selon la revendication 6 ou la revendication 7, **caractérisé en ce que** ledit catalyseur (8), au nombre d'au moins un, est placé dans la zone (5) à proximité de l'élément (4) générateur d'UV.

9. Appareil selon la revendication 6, **caractérisé en ce que** le fluide comprend de l'air ou de l'eau.

10. Appareil selon la revendication 6, **caractérisé en ce que** l'élément (4) générateur d'UV est au moins une lampe UV qui émet un rayonnement avec une distribution spectrale comprise entre 180 et 400 nm.

11. Appareil selon la revendication 10, **caractérisé en ce que** la lampe UV émet un rayonnement à des longueurs d'ondes de 183,7 nm et de 254 nm.

12. Appareil selon l'une quelconque des revendications 6 à 10 précédentes, **caractérisé en ce qu'il** est équipé d'un élément d'écoulement (7) qui déplace le fluide qui doit être traité dans l'enceinte (1).

13. Appareil selon l'une quelconque des revendications 6 à 12 précédentes, **caractérisé en ce qu'il** est équipé d'un générateur supplémentaire (9) d'ozone placé en amont dudit élément (4) à rayonnement d'UV.

14. Appareil s lon l'une qu lconqu des revendications 6 à 13 précédentes, **caractérisé n ce qu'**un filtre (10) est placé en aval de l'élément (4) générateur d'UV.

15. Appareil selon la revendication 14, **caract´risé en ce que** l filtre (10) st constitué d'une matière céramique poreuse à base d'oxyde avec un certain nombre de passages (11).

16. Appareil selon la revendication 15, **caractérisé en ce que** le filtre (10) comprend aussi du charbon actif et du carbonate.

17. Appareil selon l'une quelconque des revendications 6 à 16 précédentes, **caractérisé en ce qu'il** comprend un chronomètre pour maîtriser son fonctionnement.

18. Appareil selon l'une quelconque des revendications 6 à 17 précédentes, **caractérisé en ce que** l'appareil est constitué de sections avec des composants différents dans chaque section de façon à obtenir un système modulaire.

19. Appareil selon la revendication 6 pour stériliser des objets solides, **caractérisé en ce qu'il** comprend, en outre, un espace fermé (20) avec une entrée (22) et une sortie (24) et **en ce qu'**au moins un générateur d'ozone (9) est disposé dans l'entrée, **en c que** l'élément (4) générateur d'UV, au nombre d'au moins un, est disposé en aval de ce générateur d'ozone (9) et **en ce qu'**un élément d'écoulement (7) est disposé dans la sortie (24).

20. Système d'appareil selon la revendication 19, **caractérisé en ce que** la sortie est agencée avec un filtre (10) à base d'oxyde.

21. Appareil selon la revendication 20, **caractérisé en ce que** le filtre (10) est constitué d'une matière céramique poreuse à base d'oxyde avec un certain nombre de passages (11).

22. Appareil selon la revendication 21, **caractérisé en ce que** le filtre (10) comprend aussi du charbon actif et du carbonate.

23. Appareil selon la revendication 19 ou la revendication 20, **caractérisé en ce que** l'entrée (22) et la sortie (24) sont agencées avec des clapets (23, 25) pouvant se fermer.

24. Appareil selon la revendication 6 pour le traitement de liquides, **caractérisé en ce que**, dans un flux de liquide (30) défini, un élément est disposé pour générer et fournir de l'ozone (9, 12, 31) au liquide, et **en ce que** l'élément (4) générateur d'UV, au nombre d'au moins un, est disposé en aval dudit élément pour générer et décomposer simultanément l'ozone n radicaux libres.

25. Appareil selon la revendication 24, **caractérisé n**

ce qu'un dispositif ultrasonique (33) est dispos´ à l'entrée dudit flux de liquide (30), de sort que ledit flux de liquide st soumis à une action par ultrasons.

26. Appareil selon la revendication 24, **caractérisé en ce que** ledit flux de liquide (30) est relié à un appareil de lavage pour nettoyer, désinfecter ou stériliser des objets solides.

Fig.1.

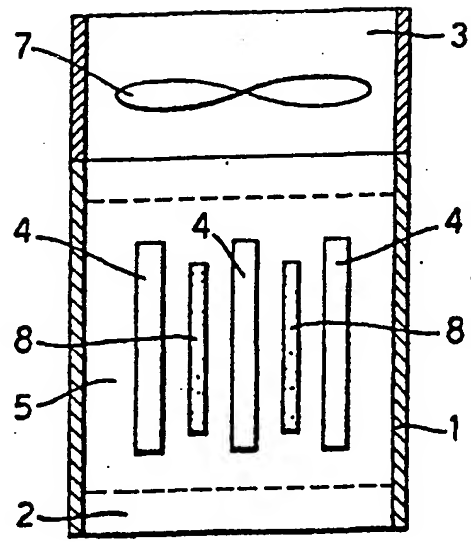

Fig.2.

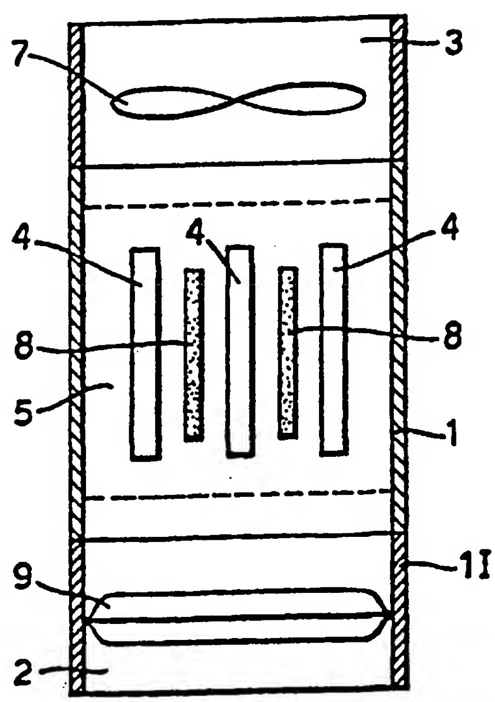

Fig.3.

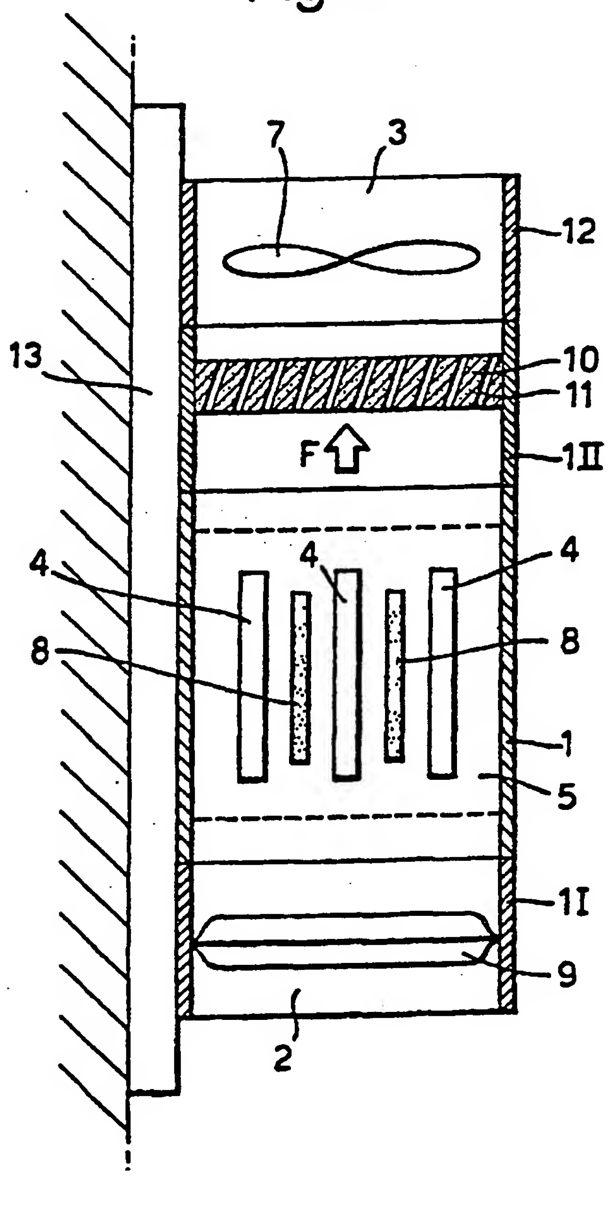

Fig.4.

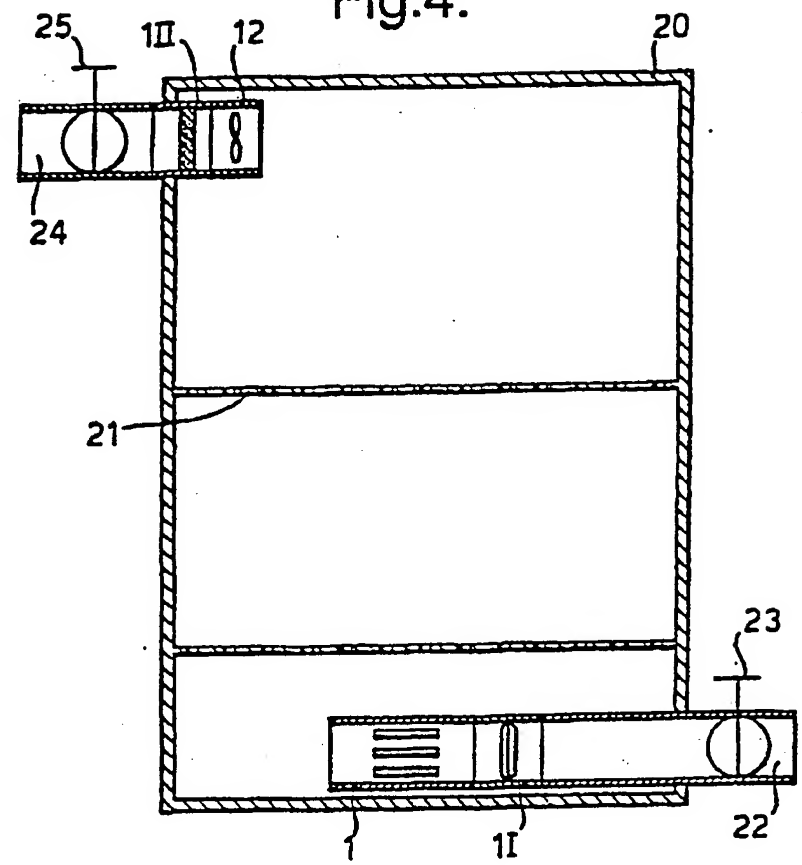

Fig.5.